ENGINEERING-EDUCATION

Bulletin of the

Society for the Promotion of Engineering Education

VOL. X LANCASTER, PA., JANUARY, 1920 NO. 5

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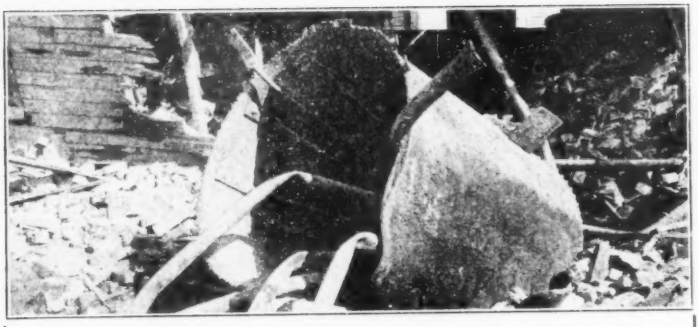

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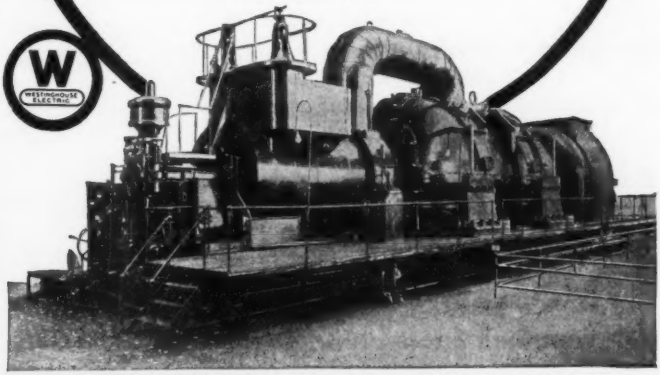

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BUSINESS TRAINING IN MINING AND METALLURGICAL CURRICULA.*

BY L. E. YOUNG,

Manager, Steam Heating Utility, Union Electric Light & Power Company, St. Louis, Mo.

During the past few years there has been considerable discussion of the value of training in economics for students in engineering. There seems to be a question in the minds of some faculty members as to the advisability of including such subjects as economics, accounting, business law, and business organization in an undergraduate curriculum in mining or metallurgy.

Needs for Business Training.

The most recent catalogue of an institution of first rank in describing the curriculum in mining engineering states that

> The object of the course is primarily to train a student for practice in the field of mining engineering. It is designed to give him the thorough fundamental training of an engineer and a breadth of education that will enable him readily to undertake work in the various lines of engineering which frequently present themselves to one of his profession. The course, therefore, when completed, places the graduate in the path of a large number of opportunities. Not only will he have had sufficient practice and training to enter upon the field of mining, but he can also engage in work in which geology and metallurgy play an important part, as well as in engineering projects related thereto.
>
> The principal objects in view are that the student upon graduation, may be enabled: first, to make and plat surface and mine surveys, and to map the topography and geology of a district; second, to analyze, value and treat minerals found upon a property, to report upon them, and to analyze metallurgical products; third, to make drawings and designs to meet the requirements of given cases; fourth, to take a subordinate position as an engineer in connection with any of the previously indicated lines of work.

* Presented at National Conference of Schools of Mines of the American Mining Congress, St. Louis, Mo., Nov. 17–22, 1919.

BUSINESS TRAINING.

In order that the young engineer may advance in his profession and in the course of years fill more than a subordinate position as a surveyor, draftsman, designer, chemist, or assayer, he must acquaint himself with many aspects of the business of mining; he must know something of the general methods and practice in the business world and, as well, the more or less localized procedure of the mining district or districts in which he is engaged. The American mining engineer has been called upon to undertake varied problems, the success of many of which has depended more upon a combined knowledge of mining technology and business than upon mining technology alone.

The other divisions of engineering are recognizing the demand for breadth of training, and it seems unnecessary to present at length reasons for including courses in economics and business in the mining and metallurgical curricula. If the reputation of an educational institution is that it develops simply good assayers, chemists, draftsmen, and surveyors and those who are responsible for the course of study in the institution are satisfied with such a finished product—with graduates who are looking no higher than the subordinate positions in large organizations—then let us continue by the well-developed and accepted curricula to produce men of such caliber and men with such a vision of their place and opportunity in the profession. Honorable as such branches of technology are as a life work, there are much more important and at the same time more lucrative positions available for the men who, in addition to having the training along the previously mentioned technical lines, have acquainted themselves with the fundamental principles of economics and business. Granting that many of the men may not have inherent qualities fitting them for leadership of the highest type, it must still be conceded that in the course of time every college trained man should take some part in solving the complex problems arising in the employment of labor, the development of mining communities, the financing of private and public enterprises, etc.

Upon graduation from mining curricula some men find employment with large corporations and may be assigned to work in some special line; others go to the small mines where their work is varied—they may be assayer, bookkeeper, surveyor, time clerk, and supply clerk, all in one person. In such a humble position a general knowledge of business procedure is invaluable. But wherever the young man may go, if he has had some training in economics and business, he has a great advantage. The chief questions are: How, when, and where can he get such training without serious interference with his technical education?

Engineering Curricula and the S. P. E. E.

For several years the Society for the Promotion of Engineering Education has been studying engineering curricula. The Committee on Economics has secured and published data on economics courses included in civil, electrical, and mechanical engineering curricula in forty-two institutions (*Proceedings S. P. E. E.*, 1918, Vol. XXVI, p. 219). Of twenty-three institutions requiring economics, the maximum number of credit hours was twelve which was required by only one institution; a minimum of two was required by six institutions; while eight institutions of the total of twenty-three required three hours.

The Committee serving in the year 1917 recommended to their successors of the Committee of 1918 that they prepare a definite scope and content of courses based on the following topics:

1. A preliminary study in commercial geography and industrial history.
2. Fundamental course in the principles of economics.
3. Application of these principles to engineering.
4. Lessons upon special application in detail engineering work.

The Committee appointed in 1918 undertook to follow the suggestions of the Commitee of 1917. The Committee dis-

tinguished between "economics" and "economy of construction" as follows:

> The term economics is taken to mean "The science of wealth" and to deal with matters pertaining to the consumption, production, exchange and distribution of the world's wealth as a more or less abstract social science. (*Proceedings S. P. E. E.*, 1918, Vol. XXVI, p. 220.) Economy of construction on the other hand should cover those principles of design and construction which accomplish desired results with the minimum expenditure of money all factors being considered, and is founded primarily upon unit costs, maintenance and life of structures, and cost of operation.

The Committee of 1918 recommended "that an outline course on economics, but no more, be required of all engineering students. Engineering has chiefly an economic aspect, that is, it has to do with the production, exchange, and distribution of wealth, and the student should become familiar with those general factors which are the framework of society's economic organization and should be led to see how engineering operations are related to them. He should understand that an engineer possesses a training that has economic value and that he will be able to 'market his wares' only as he comprehends the economic and commercial organization of society from both the theoretical and practical viewpoints."

The Committee recommended that the amount of time devoted to the formal study of economics be not more than three semester credit hours and that the subject matter be similar to the treatment in any standard text on "economics" with frequent illustrations from actual facts of commercial geography and industrial history. Recommendation was made that "special subjects in the economics group, such as accounting, labor problems, public and corporation finance, taxation, money and banking, and others, while possessing much value as information courses, do not seem to deserve a place in the engineering curriculum owing to the already crowded condition of the latter and also because an intelligent technical graduate can read books on any of these subjects understandingly without the aid of an instructor." (Idem, p. 222.)

The Committee directed special attention to the mode of administering the course in economics for engineering students, owing to the apathy of the latter toward this subject, and recommended that the subject of economics be taught by a professor of economics having a broad education and experience in corporation business, a man to whom the subject is alive and possesses a vital connection with the commercial world.

Total Hours Required per Week.

Professor Breckenridge of Yale University recently secured the opinion of teachers in departments of mechanical engineering as to the total time to be spent in class, drawing, laboratory, and study. Of eighteen replies the minimum number suggested was forty-six and the maximum fifty-four. The average was fifty and five-tenths hours. (Bulletin S. P. E. E., 1919, Vol. IX, p. 415.)

Most of the curricula in mining and metallurgy now offered require not less than the average number of hours reported by Professor Breckenridge. On the basis of the "Study of Engineering Education" made by Dr. Mann, a committee for the Society for the Promotion of Engineering recommended

That the schedules for engineering students should call for not more than 48 work hours per week (including recitation, laboratory, field work and home preparation), this time to be divided among not more than 5 subjects which require preparation outside of class exercise.

That all engineering students should be required to pursue courses which will prepare them for administrative duties and for responsible and effective citizenship.

The Report of Dr. Mann.

Dr. Mann in his report refers to the widespread agreement among professional engineers

That considerable attention should be paid to humanistic studies like English, economics, sociology, and history, not merely because of their practical value to the engineer but also because of their broad human values; and that the young engineer should have some conception of business management and of the most intelligent methods of organizing and controlling men.

The difficulty in present school practice evidently lies in the exclusion from the technical work of all consideration of the questions of human values and costs; and, conversely, the isolation of the humanistic studies from all technical interest. . . . And after all, the ultimate control of all engineering projects, as of all activities, is vested in some man's decision that the game is really worth while; and this control is likely to be more salutary, the more completely the man who decides comprehends the full import of the values and costs involved.

The report of Dr. Mann, published in 1918, has caused many engineering educators to think seriously about the real function of the institution with which they are associated, and many beneficial results of Dr. Mann's work are evident.

Curricula in Commercial Engineering.

The Bureau of Education has called several conferences to consider the development of courses in "Commercial Engineering." Reports of the suggestions made at these conferences have been published, the most important of which are as follows:

1. That from 12 to 18 semester hours be required of all engineering students covering the following subjects: General economics, cost accounting, business organization, and business law.
2. That for engineering schools desiring to extend further the commercial or industrial aspects of engineering, the following subjects are recommended as electives: Labor and employment, corporation management and finance, statistics, marketing, scientific management, psychology, transportation, and political science.
3. That the economic phases of engineering be emphasized in engineering institutions wherever possible.

A brief review of the status of curricula in Commercial Engineering and Business Administration is given in the Bulletin of the Society for the Promotion of Engineering Education of June, 1919. There have been two new types of curricula recognized, namely (1) Commercial Engineering or Engineering Administration, which is planned to be a course of study leading to an engineering degree and which includes enough technical subjects to classify it as properly an engineering curriculum; and (2) Business Administration, which

is planned to be a course of study leading to a degree in business or commerce and which is meant to be a business administration curriculum although it contains a number of elementary engineering courses as well as courses in mathematics, physics, and applied science. Both types of curricula are planned to train men for administrative work, the former containing the more engineering.

It may be well to keep these developments in business and engineering administration curricula in mind in considering the possibilities of mine administration curricula.

In commenting on this movement toward the development of Commercial Engineering, the Committee on Economics of the Society for the Promotion of Engineering Education called attention to the "desirability of recognizing the abnormal state of industrial affairs in connection with the teaching of economics" and urged "the importance of laying emphasis on sound economic doctrine. The teaching of sound economic doctrine in colleges will be one means of hastening the inevitable return of the economic pendulum to the mean position which is so necessary for further industrial development."

Types of Mining Curricula.

Any investigation of the feasibility of including training in economics and business subjects in mining and metallurgical curricula must recognize the fact that there are several types of institutions offering curricula leading to degrees in mining engineering. Obviously it will be impractical to propose any group of subjects which can be adopted uniformly in all institutions, and all that can be hoped for is the presentation of general suggestions which may be adapted to a number of the undergraduate curricula.

In considering the problems arising in connection with the curricula, control of courses, teaching staff available, etc., the institutions offering instruction in mining and metallurgy may be grouped somewhat as follows:

1. Schools or colleges existing as independent institutions and primarily for instruction in mining and metallurgy and which offer three or four years work leading to an undergraduate degree. Institutions of this type have previously limited instruction to engineering and science and the faculties have generally not included men properly qualified to offer courses in economics (as defined by the Committee on Economics of the Society for the Promotion of Engineering Education), accounting, and business organization.

2. Colleges or departments in institutions such as colleges of agriculture and mechanic arts. Usually the faculty of such an institution includes men qualified to give the business courses but in many instances the staff is not large enough to give the mining students the special attention required, so that if the mining students are enrolled in the courses offered they are not likely to be benefited greatly by the work.

3. Colleges or departments in institutions in which a college of commerce is organized. Usually the teaching staff of a college of commerce is large enough so that mining students may be segregated from the general classes taking commerce subjects and given the particular training desired.

4. Colleges offering mining or metallurgical curricula as graduate work only. These may specify that certain courses in economics and business are required for admission either to the entire curriculum or to certain advanced courses; in this way men come into the advanced courses with a broader viewpoint and a knowledge of economics, business practice and organization.

Other Methods of Securing Business Training.

The proposal that economics and business subjects be required as prerequisites for admission to mining and metallurgical curricula suggests that there are several ways in which such courses or training may be given other than in the undergraduate curricula. Briefly, they are as follows:

1. High-school or business-college courses in bookkeeping, economics, and business practice taken prior to entering college. Certain fundamentals may be secured in this way and undoubtedly, if there is no opportunity to include courses in economics, etc., in the college or university curricula, the student should be advised to elect substantial business courses in the high school.

2. College courses in economics and business to be undertaken after completion of a mining or metallurgical curriculum.

3. Training by means of extension or correspondence courses after graduation from a mining or metallurgical curriculum.
4. Independent reading and study without supervision.

Each of these plans has some advantages and, at times, may be the only means of training feasible.

Present Status of Mining Curricula.

Information is available regarding forty institutions offering curricula leading to degrees in mining or metallurgy. Several other institutions offer some work of college grade but not a complete four-year curriculum. Of the forty institutions referred to, thirty-three now have members of the faculty teaching economics as previously defined, and another expects to appoint a professor of economics as soon as a qualified man can be secured. The six institutions not having chairs of economics are colleges of applied science or mining and offer practically no humanistic subjects except English and foreign languages.

Only thirteen institutions include economics in the mining and metallurgical curricula as a required subject while seven others permit economics to be taken as an elective. Of the thirty-three institutions equipped to teach economics, there are therefore only twenty institutions offering instruction in this field of mining students. Of the thirty-three institutions one requires at least two years' college work before matriculation and as economics may be elected, the total number of institutions in which economics is either an elective or required subject is in fact twenty-one.

Several other institutions are now proposing courses in economics for next year or advise that, upon approval of the faculty, economic subjects may be substituted for certain courses now required or for technical electives.

Economics and Business Courses Now Required.

Inasmuch as the total number of institutions now requiring economics and business subjects is only thirteen, it may be

profitable to make a rapid survey of the subjects, hours, and content of the courses described.

Number 1 (a state university) requires a three-hour course in economics during the third quarter of the senior year. In addition there is a three-hour course in mine management given by a member of the mining faculty, and a two-hour course in mining law by a lawyer.

Number 2 (a college of agriculture and mechanic arts) requires a three-hour course in economics in the first semester of the senior year, followed by a three-hour course in either corporations, money and banking, or transportation problems. There are also courses in mining law and mine management.

Number 3 (a state university) requires a three-hour course in economics the first semester of the senior year, followed by a two-hour course in industrial administration, the latter being taught by a member of the engineering faculty. The mining faculty gives a one-hour course in mine administration and a two-hour course in mine examination and reports.

Number 4 (a school of technology) requires a three-hour course in economics throughout the junior year. The mining courses present the business, sociological and legal phases of mining.

Number 5 (a school of mines) requires a three-hour course in economics in both semesters of the senior year. The professor of mining gives a one-hour course in mine management during two semesters and a one-hour course in mining law for one semester.

Number 6 (a college of agriculture and mechanic arts) requires a three-hour course in economics during the first semester of the senior year, followed by a three-hour course in labor problems. The mining department gives a two-hour course in mine administration and examination, a one-hour course in economics of mining, and a one-hour course in mining law.

Number 7 (a university) requires a two-hour course in economics, followed by a two-hour course in labor problems. Most of the students have also been required to take a two-

hour course in corporation finance, a two-hour course in modern industries, and a two-hour course in accounting. The mining department has given a five-hour course one semester in economics applied to mining. If a proposed curriculum is approved, business and economic subjects will be given for five-hours throughout the junior year and probably at least one-half of the entire time of the senior year will be devoted to business courses.

Number 8 (a university) requires economics two hours during the first semester of the sophomore year, followed in sequence by accounting (2 hours), business law (3 hours), finance (2 hours), industrial management (2 hours), and contracts and specifications (2 hours). All of these subjects except the last are taught by the economics department. The mining department gives courses in mine administration, valuation, etc.

Number 9 (a state university) has not required economics but a new curriculum now includes economics (three semester hours); money, credits, and banking (three hours); business law (three hours); and accounting (two hours). These subjects are to be required for all engineering students. The mining department now gives a two-hour course in mine management.

Number 10 (a school of technology) proposes to train men for the position of mine superintendents and managers. The curriculum includes twenty commercial and non-technical topics, including economics, contracts, mining law, commercial law, bookkeeping, cost accounting, corporation finance, banking and insurance, compensation insurance, labor problems, industrial management, transportation, advertising and salesmanship, and applied psychology.

Number 11 (a university) requires four semesters of work in economics and business, as follows: Economics, first semester, junior year, three hours; business finance, second semester, junior year, three hours; and accounting, both semesters of the senior year, three hours. Courses in mine management, mine accounts, and mining law are included in

a graduate curriculum. The mining law is taught by a member of the law faculty.

Number 12 (a state university) requires a course in economics extending through both semesters of the senior year. The mining department gives a two-hour course in mine management and accounts. All of the other engineering students take additional courses in engineering economics (one hour) and engineering jurisprudence (two hours) taught by a member of the engineering faculty.

Number 13 (a school of mines) requires a three-hour course in economics during the second semester of the junior year. The mining department gives a two-hour course in mine accounting and a one-hour course in mining law for one semester.

Mining Courses with Economic Aspects.

A number of institutions, in addition to those cited above, offer and require courses in mine examination and valuation, mining law, and mine management. A few give special attention to labor problems in the mining industry. One institution includes mine examination and reports and economics of mining as required subjects in the graduate curriculum.

It is no reflection upon the men giving these courses to say that in general these courses may be classed as courses similar to those grouped by the Committee on Economics of the Society for the Promotion of Engineering Education as "economics of construction" and not truly courses in "economics."

Several institutions now offer courses in mine accounts that are entirely adequate for an engineer who does not expect to become an accountant; most of the other mining curricula would be strengthened by the addition of a general course in accounting.

Business Courses Suggested.

In the opinion of the writer, provision should be made for instruction in the following subjects, all of which should be given three hours a semester if possible:

1. Principles of economics as outlined in any standard text, giving special attention to illustrative material which should be selected carefully. The method of teaching should be a combination of lectures, recitations, discussions, and assigned problems. The course may well come in the first semester of the junior year.

2. Business organization and corporation finance. This course may be given either directly after the course in economics or may follow the course in business law and accounting. It should include a general survey of the types of business organization, the incorporation of companies, financial problems in connection with corporate organization, and the organization of mines and mining companies from an operating standpoint.

3. Business law. If other courses have not presented the fundamentals of mining law, these fundamentals may be included in this course, but the major portion of the time assigned to this course should be given to the presentation of the fundamental features of the law of business. Among the most important subjects to be considered are contracts, real property, agency, sales, and negotiable instruments. In many engineering institutions courses are now given in contracts and specifications. The course in business law may properly precede a course on engineering specifications and the writing of engineering contracts as taught by an engineering instructor.

The course in business law will probably be considered by the students as a failure unless the illustrations used have an industrial background. While the case method as used in the law schools cannot be followed closely owing to the fact that it has been developed with the idea of presenting legal procedure as well as rules of law, the use of carefully selected cases as illustrations in conjunction with a standard text on business law is highly desirable. Experience has shown that good results can be secured in teaching business law to engineering students if carefully selected cases are assigned occasionally.

4. Accounting. Students should be advised to take bookkeeping in high school. The college course should include an outline of accounting and bookkeeping; double entry; fundamental accounts and books. The fundamentals of cost accounting should be presented and the preparation and analysis of financial statements of mining corporations.

The foregoing suggestions can be modified to meet the local problems of various institutions. Several institutions are now giving courses of the nature and extent suggested while others are giving more courses and much more time than the writer suggests.

DIFFICULTIES.

Among the difficulties to be encountered in introducing such courses are (1) the prejudice of the students and some members of the faculty against courses in economics; (2) the present crowded condition of the curricula, resulting in the students neglecting non-technical subjects for technical courses; (3) the fact that several institutions have not previously employed a teacher of economics; and (4) the scarcity of qualified teachers of economics, particularly those who have sufficient knowledge of industry and of the engineering profession to appreciate the viewpoint of the engineer.

In the institutions which now provide instruction in economics, but in which the mining curricula do not include economics as a required subject, the objection to the addition of economics is generally that no time is available or that the economics faculty will not provide a proper course for engineers. The latter objection may be overcome by coöperating with the economics faculty and preparing a detailed outline of the courses desired, based upon the experience of the institutions in which economics courses for engineers have been established successfully.

The objection has been raised that the mining curricula are so crowded that the addition of non-technical courses will result in the elimination of essential engineering work. Two plans may be suggested to meet this objection, as follows:

1. Provide an undergraduate curriculum to be known as the "mine administration curriculum"; include in it the economics and business courses desired; and for this curriculum give a Bachelor of Science degree but not in engineering. In a number of institutions this is not feasible, as the degrees conferred are exclusively in engineering.

2. Add a fifth year, including some graduate work in mining but largely courses in economics and business. The demand for a four-year instead of a five-year course will probably prevent the successful development of the latter plan in many institutions.

Institutions of the first rank have been able to provide as much as twelve semester hours time for economic subjects. It may not be advisable to introduce more than six hours when the new courses are inaugurated. But before the entire proposal to introduce economics courses is dismissed on the ground that no time is available, the following questions should be asked searchingly by each administrative officer in regard to his own institution:

1. Are the students now matriculated properly qualified to do collegiate work?

2. Is the undergraduate instruction given effectively?

3. Is the student's time taken up with routine, details, or courses consisting chiefly of informational matter which can be read independently after graduation?

As thirteen institutions have endorsed the plan of giving instruction in economics and business and have found it feasible to adjust the curricula to permit such courses to be given, it is no longer logical to dismiss the problem by saying "it cannot be done" or "it will not work." With students properly qualified to enter college and with a competent faculty, it has worked.

New Economic Problems.

In conclusion, it seems appropriate in urging the timeliness of training in economics for mining students to refer to the various broad economic problems being discussed in the United States and Europe, among which is the nationalization of mines. Serious consideration is being given to this matter in Great Britain, and whether or not we favor or oppose the plan being discussed, it is important that the men who are to be the leaders in the mining profession shall be able to think clearly upon such momentous questions.

On August 18, 1919, the Prime Minister addressed the British Parliament regarding the report of the Coal Commission as follows:

> We have accepted the principles of unification and reorganization, and we think that even the owners realize that there is a very great case

made out for that, because you have the waste which is due to a large number of different enterprises running in the same area under different management—waste of power, waste in management, waste in distribution. There is also undoubtedly a case to be made out for giving the miners a greater interest and voice in the working conditions which affect them. Therefore we make this recommendation—that in view of the fact that the living and livelihood of the miners depend on the way the mines are worked, means should be devised for securing their cooperation in shaping the general conditions of the industry without interfering with the executive control of individual mines.

Now I come to our recommendation with regard to unification. It is that the industry shall be so organized as to reduce to a minimum the expense of management and working charges, and with this end in view the country should be divided into defined areas, in each of which the amalgamation of neighboring mines should be undertaken within a limited period, say two years. and that the workers in and about the mines should have directors representing them in the body controlling the area group to which they belong.

The government proposes to prepare a scheme and submit it to Parliament with the least possible delay, by which the minerals should be purchased by the state and funds raised for the purpose of promoting schemes for the social improvement and amelioration of the conditions and amenities of life in the mining villages. The state should not purchase the business of mines.

The plan proposed was not acceptable to trade unionists in general, and by a vote of 4,478,000 to 77,000 a resolution was carried which in effect demands the nationalization of the coal mines. The nationalization of coal mines has become one of the leading questions of the day in England.

If nationalization of mines becomes a fact in England, it is not unreasonable to expect there will be a serious consideration of the same subject in America, and if it becomes a critical question here, the mining profession must be ready to consider it on broad lines.

The time appears to be at hand when the mining engineer must take a more prominent part in the affairs of the nation; he can do this much more effectively if he has a broad training and is qualified to consider the fundamental economic problems of the mining industry and of the nation. Collegiate

courses as proposed will aid materially in furnishing this training.

The responsibility of the faculty in this matter cannot be overlooked. A recent publication of the engineering school of a leading university contains the following statement:

> The aims which have served as controlling considerations in the selection of the teaching staff and in the laying out of the instruction of the school are: to train men to think; to lay a broad and deep foundation with an outline of the superstructure which can be filled in gradually from the training and observation which come from practical experience; to encourage the student so thoroughly to understand each problem, that he can apply the same principles intelligently to the solution of entirely different kinds of problems, and finally to train men to be good citizens as well as good engineers.

As the faculty is responsible for the breadth and depth of foundation and the outline of the superstructure, the subject of training in economics and business should be considered with the care and the thought which its importance warrants.

COLLEGE SHOP INSTRUCTION.

BY F. G. HIGBEE,

Professor and Head, Department of Descriptive Geometry and Drawing, State University of Iowa.

What is the purpose of the college shop? Just what function does it perform in the educational process of which it is a part? And how is the college shop operated? These are questions which may be answered in as many ways as there are college shops; there seems to be no general agreement concerning the purpose, the function, and the operation of this important feature of engineering education. It would seem, therefore, that it might be worth while to answer these questions without regard to conditions as they may exist and to set down what a college shop should aim to accomplish and how it may do this merely for the sake of establishing an ideal which might be used as a gauge for college shop instruction.

Broadly speaking the purpose of the college shop should be to provide each student of engineering with the opportunity to study at close range the business of manufacturing, including all of the elements which form a part of the process of production. In other words the college shop should be a manufacturing organization complete in every detail wherein a student may have the opportunity for first hand study of operating conditions and the experience of being a unit in each department of such an organization, always of course under proper instruction and close supervision.

The organization and equipment of a college shop to operate under such conditions is neither a difficult nor an expensive matter, but there are certain prime essentials which must be kept constantly in the foreground if the plan is to be a success. The first and most important of these essentials is the fact

that even though the shop is a manufacturing and producing organization it is, nevertheless, a part of an educational process and that, therefore, its efficiency is not to be measured in terms of production, as one would measure a commercial establishment, but rather in terms of the opportunities it affords students for learning the methods by which production may be accomplished. This condition necessarily effects shop management to a certain degree, but the shop should be organized as near as possible on a commercial basis. Another essential of first importance is the elimination, to a much greater degree than is usually found in college shops, of exercise work and the substitution therefore of work on actual parts of some article of commercial use. This means that the shop must be manufacturing some article whose several parts will afford the variety of operations necessary for a complete and comprehensive experience in production, and an article which the student may follow through the organization from drafting room to shipping floor. This is essential if the idea of shop management and production is to be completely carried out, and while it is not difficult to find such an article it must be selected with some care in order to provide the proper variety of work and to avoid the danger of attempting something beyond the capacity of a college shop.

It may seem that the two ideas of conducting a college shop on a commercial basis and at the same time making it a part of an educational scheme are directly opposed, and in a measure they are. If the educational feature of this plan is to predominate the commercial feature must, of course, be subordinate and, in consequence, the shop can not be expected to produce according to commercial standards nor to operate at a profit. But this is not necessary. Since educational institutions are not conducted for profit it will be possible to operate the college shop just as thought it were producing at a profit. And even though it will doubtless operate at a loss it is not improbable that the "educational profit" per student will be materially increased.

Let it be assumed for the sake of demonstrating the possi-

bilities of this plan of shop education, and not because the arrangement is necessarily the best, that the shop organization is divided into four general departments of instruction; the engineering department, the production department, the assembly department, and the business department. The form of the organization and the function of each department may be varied to suit local conditions if need be; the essential part of this plan is not the form, it consists in having organization and keeping it as efficient as possible both as to production and to teaching.

The work of the engineering department should include the work now usually done in colleges by the department of drawing and design. There is no especial need to reorganize any college in order to carry out this plan of shop instruction, but there must be coördination and coöperation. In addition to furnishing the college shop with complete drawings of the article for production, including the drawings for all tools, jigs, and fixtures, it should be the function of this department also to study and plan the progress of the work through the shop and to furnish instruction cards for the workmen. It will be evident, therefore, that from an educational standpoint this department must teach drafting and design, tool design, drafting-room management, including the filing and indexing of drawings and information, as well as to teach the functions of a planning department and its proper operation. It is not to be assumed that a student is to take the entire work of such a department in one dose; on the contrary he should pass back and forth from one department to another in that order which will best promote his progress. For example, after he has learned to make a shop drawing he should enter the production department to learn how it is used, and after acquiring some shop experience he might reënter the engineering department to take up some other work in that phase of the development of the manufacturing process.

The advantages of such an arrangement are more or less obvious; in no better way can a student be made to appreciate what is required of a drawing and what it is for, of how shop

considerations effect design, and of what the functions of an engineering department are. The fact, too, that he is a part of a shop organization is an education in itself.

The producing department may be organized without changing the arrangement which is common in most college shops. There should be of course a pattern shop, a foundry, a forge shop, a machine shop, and a tool room. The student should follow the progress of a number of parts through each of these shops in turn and in addition perhaps study the production of some special pieces designed to bring out special operations not included in the manufacture of the regular product.

As a general thing college shops devote too much time to teaching operation with the result that the student gets the notion that he is "learning to run a lathe" or "to make a pattern." If time were available the acquisition of such ability would be an extremely desirable thing for him both practically and educationally, but with the limited amount of time allowed for shop education the acquiring of the ability to operate this or that machine or to perform this or that operation in shop production is a secondary consideration. The student is in the shop primarily to learn how things are done rather than to acquire the ability to do them himself. He should be primarily an observer and secondarily a "doer." To learn production with this ideal prevailing will require a method of teaching not usually found in college shops.

Each department of the shop should be in charge of a foreman *who is also a teacher,* and under him there should be at work enough expert workmen to illustrate all phases of the work he is teaching. The student then should enter each of these departments in turn as an observer; in his possession he should have a set of question sheets designed to cover the entire range of operations of machines and tools in that department, and it should be his business to find out, with the assistance of the foreman and his workmen, the answers to these questions. When this has been satisfactorily done as much time as can be allowed—and the more time the better—

should be devoted to the learning of the trade under the guidance of the workmen. It must be apparent that under such an arrangement the student may acquire in a short time a wide range of information and an intimate knowledge of shop production. The value of all of this depends absolutely upon the comprehensiveness of the question sheets, the thoroughness with which it is required they should be grasped, the searching character of the investigation demanded, and the amount of assigned reading.

Such a plan of operation puts the college shop on a producing basis independent of student workmen, yet at the same time it affords the opportunity for close observation of work being done under commercial conditions by expert workmen. It may be justly argued that this method of teaching allows very little time for the student to learn to perform shop operations himself; while this may doubtless be the case it is to be remembered that the function of the college shop is not to train operatives but to teach the larger phases of shop production; the function of each machine and tool, of each department, of each unit in the shop organization, the possibilities and limitations of materials, of machines, and of men, and the relation of all of these to the general process of manufacturing.

Having studied production the student should now take up some features of shop training often neglected in college shops. These have been grouped for convenience under the assembly department, but it is not important to keep them there. Indeed, it may be found in some cases to shift some of them to other departments would result in a better arrangement. In this department the student should study the proper methods of inspection of parts, the assembly of parts into the complete machine and of course as much time as possible should be devoted to actual practice of these methods. Following inspection and assembly such matters as painting and finishing should be taken up, the testing of the machine, and crating and packing for shipment. There should also be an opportunity to study the purpose and operation of the

stock room for the storage of raw materials, patterns, and finished parts and their issuance to the shop. These are operations of minor importance in shop production which may account for the fact that they are usually neglected, but nevertheless they are important enough to warrant some study if the student is to acquire a complete knowledge of production.

The study of business management should be included in shop education as well as the study of production. It is the lack of such information that causes employers sometimes to stand amazed at the ignorance of the college graduate! The purchasing of supplies, the method of conducting advertising and sales, accounting, and shop organization are the essential things to be studied, and after an appreciation of their importance has been impressed upon the student by his experiences in the shop these important features of management should be welcomed by the student as a part of shop training.

In conclusion it may be seen then that the purpose, the function, and the operation of the college shop should be established on a basis designed to provide a broad training in the business of manufacturing, to teach the "why" rather than the "how" of shop production, and to afford the opportunity of acquiring this training and experience in a laboratory of shop training conducted on a commercial basis. Necessarily the description of such college shop and its operation here given is very general, but from even this bare outline it should be clear that such a shop is not an impossibility. It should also be apparent that the plan of instruction here outlined offers a solution for that lack of knowledge so often encountered among technical men of the thousand and one small things in shop management of which the great whole is built.

PRELIMINARY REPORT OF COMMITTEE NO. 22, INTELLIGENCE TESTS.

The six examinations that were prepared by Committee No. 22 on intelligence tests have been given to a large number of engineering colleges represented in the Society. Approximately ten thousand engineering freshmen have taken these tests and the Committee is now receiving data from the participating colleges on the test scores. We are now engaged in the task of preparing norms of performance on each of the colleges by which the standing of each student in each test may be determined relative to his classmates or relative to engineering freshmen in general. Later other data sheets will be sent to the participating colleges for recording the scholastic standing. These will be checked against the test scores by correlation statistics. The same procedure will be applied with the high-school scholarship and with entrance examinations in an effort to determine the predictive value of intelligence tests, the special examinations, the college entrance examination, and high-school scholarship.

One of the most important tasks of the Committee is to ascertain whether or not we can reduce the number of failures by properly selected criteria for admission without reducing the number of students admitted to each college. For this reason it is highly desirable that each participating college keep a close record of the reason for withdrawal of all students that drop out during the college course. This will be the subject of a special inquiry and the predictive value of each entrance criterion will be determined with respect to the failures.

The Committee is also anxious to enlist the coöperation of a large number of representative secondary schools and for this reason four thousand sets of test papers have been printed. The members of the Society will assist consider-

ably in this investigation by calling the attention of representative secondary schools to the fact that these test papers are now available for high-school seniors.

C. R. DOOLEY,
D. C. JACKSON,
W. T. MAGRUDER,
ANSON MARSTON,
L. L. THURSTONE, *Chairman.*

EDITORIAL.

How Are We to Recruit the Teaching Profession?—The demand for engineers and especially men of experience with specialized knowledge in industry, has increased enormously since 1914. This is, of course, pleasing to all interested in the promotion of engineering education but there is, however, one effect which is a matter of serious concern to all, that is the draft which has been made on engineers engaged in teaching, an increasing number of whom are leaving the teaching profession to accept more lucrative positions in commercial life. Most of these men prefer teaching; they are interested in it and are successful, but the compensation allowed teachers has decreased relatively so much that many have been unable to refuse the offers and especially opportunities of commercial life. Another factor which produces the same effect is the increase in the freshman class of nearly every engineering school in the country. This means if the attendance in the freshman class becomes normal in the next two years, a very decided increase in the attendance at engineering schools. These two factors are causing a dearth of trained teachers in engineering schools. The immediate effect of this shortage of teachers has been the creating in many schools of large sections in all subjects. The teaching staff must be materially increased if we are to retain sections of a size which can be taught efficiently or even taught at all. The Secretary of this Society has received a large number of notices of vacant positions not only of the lower grades, but in all positions in engineering schools.

The situation is extremely critical and some organized effort should be made to increase the teaching staff and provide properly trained teachers of engineering subjects. Of course, one of the controlling factors in the whole situation is the matter of salaries. This, however, seems to be slowly but surely

adjusting itself and we may expect in the next year or two, to find teachers' salaries commensurate with those paid for commercial work. This, however, is not the controlling factor. Greater opportunities for investigation, study and writing must be provided for the engineer engaged in teaching. This is one of the reasons why in the past so many good men have entered the teaching profession. Today another factor is entering, namely, a necessity for all teachers of engineering to have at least a year of practical engineering work before becoming teachers. It is no longer feasible or practical to select a man having high academic records from the senior class, appoint him as an assistant, have him devote his entire time to academic instruction and gradually promote him in the teaching profession. The students of our engineering schools no longer take kindly to this type of instruction. Many of them have had experience themselves and demand greater experience on the part of the engineering teacher.

COLLEGE NOTES.

University of Illinois.—*Registration of Students.*—The number of undergraduate students registered in the College of Engineering of the University of Illinois on November 1, 1919, is as follows:

Architecture	127
Architectural Engineering	147
Ceramic Engineering	47
Civil Engineering	326
Electrical Engineering	445
General Engineering Physics	2
Mechanical Engineering	515
Mining Engineering	58
Municipal and Sanitary Engineering	11
Railway Engineering	36
Total	1,714

Engineering Investigation of National Importance to be Carried on by the Illinois Engineering Experiment Station.—

In 1915 Mr. Ambrose Swasey, of Cleveland, Ohio, a member of the celebrated firm of Warner and Swasey, makers of mounts for large telescopes and of machine tools of the highest grade, gave a fund of several hundred thousand dollars, the income of which was to be used "for the advancement of arts and sciences connected with engineering and for the benefit of mankind." The income of this fund has been given in small amounts to various engineering investigations by the Engineering Foundation, which is the body organized to administer the fund. Last spring the governing board of the Engineering foundation (of which Dr. W. F. M. Goss, former dean of the college of engineering is a member) decided that it would be advisable to give the bulk of the income for the support of one major research, and they asked the National Research Council, a body organized to coördinate war-time scientific research, to recommend some piece of research to be supported.

During the war the National Research Council had organized a committee to study the failure of crank shafts of airplane engines, of welded ship plates, and of other metal parts of machines under the repeated loads applied to them in service. The Committee on Fatigue Phenomena in Metals was the somewhat formidable title of the committee. The chairman of that committee was Prof. H. F. Moore of the department of Theoretical and Applied Mechanics, and during the war and afterward some small pieces of research work were carried out under the auspices of the committee, mainly in the materials testing laboratory of the college of engineering of the University of Illinois by the chairman of the committee, and by W. J. Putnam, and A. G. Gehrig. The National Research Council recommended that the bulk of the income of the Engineering Foundation be given to the support of an extensive investigation of the resistance of metals to fatigue under repeated loading, and that Professor Moore be asked to take charge of the investigation.

This suggestion was followed and the formal arrangements have just been completed for the active prosecution of this

work, with headquarters and a laboratory at the University of Illinois. The financial support for the investigation will amount to $30,000, and the investigation is expected to extend over a period of two years. Material for study and apparatus is already arriving, and a room is being fitted up for the installation of the score or more of special testing machines which will be required for the investigation.

The investigation is under the joint auspices of the Engineering Foundation, the University of Illinois Engineering Experiment Station, and the National Research Council, the last-named body being represented by an advisory committee of nine members, of which Professor Moore is chairman. In addition to the funds supplied by the Engineering Foundation, the University furnished Professor Moore's services, light, heat, power, a laboratory room, and the use of the standard testing equipment of the materials testing laboratory.

The investigation is one of the most important ever undertaken by the Engineering Experiment Station. The fund available is the largest ever devoted to a single engineering investigation at Illinois, and one of the largest ever devoted to any investigation at the University. The sudden failure of crank shafts, axles, and springs is all too common in automobiles, railway equipment, and machinery in general; and the ability of the new high-strength steels to resist repeated loading needs much more study. The problem is one of national interest and the September 27 issue of the *Literary Digest* gave a summary under the title "Tired Metals," of a recent lecture by Professor Moore on the subject.

The State University of Iowa.—I think perhaps it is worthy of note that the College of Applied Science, which is the engineering college of the State University of Iowa, has taken what it thinks to be a step in advance toward the devotion of the four-year college course in engineering to the development of the fundamentals of the profession of engineering as dis-

tinguished from the development of specialists in one or another branch of engineering.

The college offers five distinct courses, namely courses in Civil Engineering, Mechanical Engineering, Electrical Engineering, Chemical Engineering and Chemistry. These are all four-year courses except the course in Chemical Engineering, which is a five-year course.

By action of the faculty last year, which action was put into effect this year for the first time, the first-year work in the four engineering courses is alike and the civil, electrical, and mechanical courses differentiate only in the senior year and then only to the extent of twenty of the thirty-four semester hours constituting the year's work.

All students in these courses receive the same instruction in the ordinary fundamentals of mathematics, chemistry, drawing, shop work, surveying, physics, descriptive geometry, mineralogy and geology, mechanics, materials of engineering, hydraulics, machine design, stresses in static structures, steam engine, the generation, transmission and delivery of electric power.

They also receive the same instruction in economics, accounting, business law, English and metallurgy.

In the senior year special work in surveying and railroad surveying, structural engineering, road engineering and sanitary engineering is given to civil engineering students. Special work in the theory of electricity, electro-chemistry, telephone and telegraph, illumination, dynamo design and power plant engineering is given to electrical engineering students. Special instruction in shop work, heat engines, engine design, heating and ventilating and power plant design is given to mechanical engineering students.

Pennsylvania State College.—The new machine and forge shop building was informally dedicated on the evening of November 25, just a year after the date when the old industrial shops were destroyed. Since that time a new building devoted to wood-working has been completed and equipped

with the most modern machinery and a second building for metal-working.

A third building will be in use at the beginning of the second semester and will contain the testing materials laboratory, the highway and masonry laboratories, the offices and recitation rooms of the Department of Mechanics and Materials of Construction. Each of the buildings above mentioned is three stories in height and two of them have basement floors.

The new Mechanical Engineering Laboratory has been started and its completion is promised in time to receive the new equipment before College opens next September. The new building will be 60 feet by 165 feet with a basement for condensing apparatus and a gallery floor for lighter equipment.

PITTSBURG SECTION OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

First Regular Meeting.—Wednesday evening, December 3, 1919, 8 P.M., at the University Club. (Take Fifth Avenue car and get off at Bigelow Boulevard. The Club is on Bigelow Boulevard between the Syria Mosque and the Pittsburgh Athletic Association.)

Engineers, employers of engineers, teachers of engineers, and all others interested in engineering education are invited.

General topic for the 1919–1920 meetings: "How Can the Education of Engineers be Improved?"

Special topic for the first meeting: "What Are the Chief Defects in the Product of Engineering Schools?"

Speakers: Mr. B. F. Groat, Aluminum Company of America, 15 minutes; Mr. D. F. Crawford, Locomotive Stoker Company, 15 minutes; Mr. Carl S. Coler, Westinghouse E. & M. Company, 15 minutes.

General discussion: Limited to three minutes to each speaker.

Special discussion: "What Defects are Properly Chargeable to the Engineering Schools?" F. L. Bishop, dean, School of Engineering, University of Pittsburgh, 10 minutes. "What Defects Can the School Hope to Remedy?" W. E. Mott, dean, School of Applied Science, Carnegie Institute of Technology, 10 minutes.

P. M. DYSART, *Chairman.*
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BOOK REVIEW.

Geodesy.—By George L. Hosmer. John Wiley and Sons, Inc. 1st Edition, 377 pages, 6×9, 115 cuts, cloth, $3.50 net.

Contains considerable more information than could be covered in class in the time usually available for such work. Has a large number of excellent cuts of the various instruments and apparatus used in geodetic work. The chapter on astronomical observations is not in sufficient detail for teaching purposes. It assumes a general knowledge of astronomy and the ordinary methods of determining time, latitude, and azimuth. It includes a chapter on the determination of the earth's figure by means of gravity measurements. Devotes forty-six pages to an introduction to the method of least squares and the adjustment of observations by that method.

L. W. McI.

MATHEMATICAL COMMITTEE SOON TO ISSUE PRELIMINARY REPORT.*

A preliminary report on "The Reorganization of Introductory Courses in Mathematics in Secondary Schools" will shortly be issued by the National Committee on Mathematical Requirements.

* *School Life*, Vol. III, No. 10.

This report has been prepared by a representative subcommittee. It has not as yet been considered by the national committee, but its publication as a basis for discussion by teachers' organizations, committees, and local groups has been authorized.

A report on "The valid aims and purposes of the teaching of mathematics in the light of recent criticisms" will, it is hoped, be ready for distribution by January. In it an attempt will be made to state precisely and succinctly the mathematical training that every citizen should secure. The findings of this report can then be made a basis for the determination of precisely what and how much mathematics should be required of all students.

An extended investigation of "Experimental schools and courses" is being undertaken for the committee by Mr. Raleigh Schorling of the Lincoln School. Detailed plans for this investigation were approved by the national committee at its last meeting in New York City on November 1.

Mr. J. A. Foberg is preparing a report on "Mathematics in junior high schools."

Prof. A. R. Crathorne has recently submitted a report giving the results of his investigation of "Change of mind between high school and college as to life work." Professor Crathorne is at work on an extended investigation entitled "A critical study of the correlation method as applied to grades."

A statement of general principles to govern the proposed revision of college entrance requirements has been tentatively approved by the committee. This statement has been sent out to some fifty representative colleges and universities for their criticism and comment.

The committee has sent letters to all teachers' organizations having mathematical interests, of which it has been able to learn, asking their coöperation and offering the assistance of the committee.

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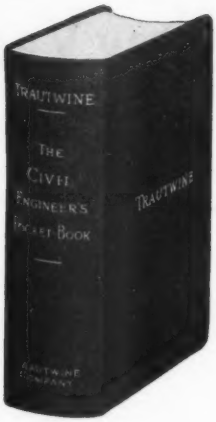

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PUBLICATION COMMITTEE

Arthur M. Greene, Jr., John F. Hayford, F. L. Bishop

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